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ABSTRACT

Using data from the National Assessment of Educational Progress (NAEO) for 1990, 1996, and 2000, this study examined trends related to race and socioeconomic status (SES) in student mathematics achievement, beliefs, classroom experiences, course taking patterns, and teachers' educational backgrounds. Although overall mathematics achievement increased between 1990 and 2000, race-related achievement gaps did not improve. SES differences appear to account for some, but not all, race-related differences. An examination of classroom practices revealed many similarities in students' experiences that were consistent with the "Curriculum and Evaluation Standards" of the National Council of Teachers of Mathematics. However, other aspects of mathematics instruction, such as the role of calculators and the use of multiple-choice assessments, were found to correlate with student race and SES. In addition, there were race- and SES-related differences in students' beliefs, such as whether learning mathematics was viewed as fact memorization. These correlations with race persisted even after controlling for SES. The results suggest that white, middle-class students are experiencing more of the fundamental shifts called for in the "Standards." However, the NAEP is not designed for making case-and-effect inferences regarding instructional methods and student outcomes. This study reveals similarities and differences in students' classroom experiences and attitudes, thereby shedding light on factors that could shape achievement differences. (Contains 9 figures, 6 tables, and 44 references.) (Author/SLD)

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A Closer Look at U.S. Mathematics Instruction and Achievement: Examinations of Race and SES in a Decade of NAEP Data

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Paper presented at the annual meeting of the

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Abstract

In 1989, the National Council of Teachers of Mathematics (NCTM) published the *Curriculum and Evaluation Standards*, setting a new course for K-12 mathematics teaching and learning intended to mathematically empower all students. More than a decade later, this study provides an important and timely analysis of trends in mathematics instruction and outcomes, with attention to race- and SES-related disparities.

Utilizing 1990, 1996 and 2000 data from the National Assessment of Educational Progress, this study examines race- and SES-related trends in student mathematics achievement, beliefs, classroom experiences, course taking patterns, and teachers' educational backgrounds. Although overall mathematics achievement increased between 1990 and 2000, race-related achievement gaps did not improve. SES differences appear to account for some, but not all race-related differences. An examination of classroom practices revealed many similarities in students' experiences that were consistent with the NCTM *Standards*. However, other aspects of mathematics instruction, such as the role of calculators and the use of multiple-choice assessments, were found to correlate with student race and SES. Additionally, there were race- and SES-related differences in students' beliefs, such as whether learning mathematics was viewed as fact memorization. These correlations with race persisted even after controlling for SES.

The results suggest that White, middle-class students are experiencing more of the fundamental shifts called for in the *Standards*. However, the NAEP is not designed for making cause-and-effect inferences regarding instructional methods and student outcomes. This study reveals similarities and differences in students' classroom experiences and attitudes, thereby shedding light on factors that could shape achievement differences.

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In the past, lower-SES and minority students have received more than their share of rote-based mathematics instruction (e.g., Anyon, 1981; Ladson-Billings, 1997; Means & Knapp, 1991). The National Council of Teachers of Mathematics' (NCTM) vision of problem-centered instruction for all students challenges the status quo and could have the potential to correct past inequities (NCTM, 1989; 1991; 1995; 2000). The reformers' vision offers a dramatic departure from traditional mathematics instruction centered around the memorization and practice of teacher-given rules. NCTM calls for mathematics instruction to be centered around students' exploration and discussion of challenging problems. Additionally, NCTM promotes revised curricular goals for grades K-12 to include greater emphasis on conceptual understanding of measurement, geometry, data analysis, probability, algebra, and number. NCTM also argues that a wider variety of tools should be used to enhance students' learning, including manipulatives, calculators, and computers. NCTM intends its vision to reach and mathematically empower all students, including those students previously under-represented in mathematics-based careers.

After a decade of reform, it is clear that the *Standards* documents have made a strong, national impact. By 1993, over half of the states had changed their testing or curriculum recommendations in light of the *Standards* (Usiskin, 1993). Additionally, the National Science Foundation funded thirteen curriculum development projects to implement NCTM's vision. These curricula were making their way into schools by the mid-1990's, and their use is continuing to expand.

Despite the *Standards'* impact and apparent potential to address past inequities (Stiff, 1990), achievement gaps between black and white students began widening during the past decade, after narrowing in the 1970's and 80's (Campbell, Hombo, & J. Mazzeo, 2000; Jencks & Phillips, 1998). Lee (2002) found that during the back to the basics movement, the black-white gap in mathematics and reading achievement narrowed due to increases in black students' achievement while the achievement of white students remained steady. Then, Lee argues, during the past decade of reforms pushing for more complex problem solving skills, achievement gains have been greatest for high achieving

white students, and this has contributed to the widening of the gap. These trends raise the important question of whether recent reforms are, indeed, reaching all students.

Other studies of black-white achievement gaps have considered the role of teachers, curriculum, schools, student motivation, and student resistance (e.g., Banks, 1989; Cook & Ludwig, 1998; Ferguson, 1998a; Ogbu, 1995; Steele & Aronson, 1998). Such discussions tend to focus on the overall academic performance and experiences of black students, as opposed to an in-depth examination of achievement and instructional practices in a particular subject area, such as mathematics. This trend was noted by Lee (2002), who concluded his general analysis of trends in achievement data by urging subject matter specialists to examine the issue in their areas of expertise.

This paper focuses specifically on students' achievement and learning experiences in mathematics, which is particularly important to consider in relation to equity because it is used as a key gatekeeper for high status occupations. Previously, researchers in mathematics education have given some attention to black-white gaps in mathematics achievement, but with limited depth and little attention to interactions between race and SES (Lubienski & Bowen, 2000; Tate, 1997)[1]. By examining race- and SES-related gaps in mathematics achievement and instructional practices and giving attention to interactions between race and SES, this study highlights ways in which race-related achievement gaps could be due to differences in students' access to empowering mathematics instruction.

The National Assessment of Educational Progress

The National Assessment of Educational Progress (NAEP) is an important tool for monitoring trends in mathematics achievement, student attitudes and beliefs, and instructional practices. The NAEP is the only nationally representative, ongoing assessment of U.S. academic achievement . The NAEP measures student performance at 4^{th}, 8^{th}, and 12^{th} grades in mathematics and other subject areas. The NAEP also provides

[1] In a survey of 3,011 mathematics education research articles published between 1982 and 1998, Lubienski and Bowen (2000) found 323 articles pertaining to gender, yet only 52 pertaining to social class, and 112 pertaining to race (with 47 of these concerning black students). Only 13 of the 3,011 articles considered race and class together.

information from student and teacher questionnaires regarding mathematical backgrounds, beliefs, and instructional practices.

In order to help the reader interpret NAEP results, some information about NAEP is necessary. There are actually two different NAEP assessments that are administered to a nationally representative subset of students: the Long-Term Trend NAEP and the main NAEP.[2] The Long-Term trend assessment was created in 1973 and has remained constant over time. Hence, the content of the test questions is that which was deemed important in 1973. Most analyses of race-related trends in NAEP achievement data have drawn from the Long-Term Trend assessment.

In contrast, the framework that determines the content of the main NAEP assessment is responsive to national trends, such as the NCTM reforms. Since 1990, the main NAEP mathematics assessment has been shaped by a framework based on NCTM's *Curriculum and Evaluation Standards for School Mathematics* (1989). Hence, NAEP assesses students' performance on both multiple choice and open-ended questions over the five mathematics strands emphasized by NCTM: number/operations, geometry, measurement, data analysis, and algebra/functions. Additionally, NAEP survey questions administered to students and teachers are designed to identify the extent to which students' classroom experiences are aligned with NCTM's vision for mathematics instruction. Hence, the NAEP is designed to monitor students' access to both the curriculum and instructional practices deemed important by current leaders in mathematics education. This assessment was administered in 1990, 1992, 1996 and most recently 2000.

Several publications have delved into particular aspects of the 1996 and earlier NAEP mathematics assessments, such as students' skills in estimation and in solving contextualized mathematics problem (Mitchell, Hawkins, Stancavage, & Dossey, 1999), teacher and student practices in mathematics classrooms (Mitchell, Hawkins, Jakwerth, Stancavage & Dossey, 1999), as well as students' performance in each of the 5 mathematics strands: number, algebra, geometry, measurement, and data analysis/probability (Silver, & Kenney, 2000).

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[2] There is also a third NAEP assessment, the State NAEP, which is administered to samples from each participating state.

Although most NAEP reports focus primarily on overall trends in student achievement and instructional practices, some reports have given attention to race, SES and gender (e.g., Mitchell, Hawkins, Jakwerth, Stancavage, & Dossey, 1999; Reese, Miller, Mazzeo & Dossey, 1997). Most notably, Strutchens & Silver (2000) reported on a variety of race-related disparities in NAEP data related to mathematics achievement, students' beliefs about mathematics, and teachers' instructional practices and emphases. Strutchens & Silver's findings in each of these areas will be summarized briefly.

Students' mathematical attitudes and beliefs, although shaped by a variety of factors, are likely linked to both students' mathematics achievement and the instruction they receive. Strutchens and Silver (2000) identified several factors that did *not* correlate with the black-white achievement gaps. Briefly, according to the 1996 NAEP data, black and Hispanic students reported liking mathematics and believing mathematics is useful at least as much as their white counterparts. Furthermore, students' beliefs about the link between effort and achievement did not correlate with achievement gaps. In 1996, 67% of white 8th graders versus 87% of black 8th graders and 86% of Hispanic 8th graders agreed with the statement, "Everyone can do well in math if they try."

Still, Strutchens and Silver identified some differences in students' beliefs that could be related to the mathematics achievement differences, as well as to the instruction students received. Black and Hispanic students were more likely than white students to agree with the statements, "There is only one way to solve a math problem" and "Learning mathematics is mostly memorizing facts."

Strutchens and Silver also found a number of teacher-reported aspects of mathematics instruction that were similar for white, black and Hispanic students[3]. These areas included the use of manipulatives, the use of "real-life" mathematics problems, and student collaboration. Additionally, time spent on instruction did not correlate with achievement gaps, with black students being most likely to have a teacher who reported spending more than 4 hours per week on mathematics instruction.

However, there were some instructional differences that correlated with achievement gaps. white students were allowed more access to calculators for daily use and on tests

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[3] The NAEP sample involves a random sample of students, and not teachers. Therefore, claims must be made at the student, not teacher, level.

than were black or Hispanic students. Black and Hispanic students were more likely to be assessed with multiple choice tests, particularly at the 4th grade level. Finally, white students were most likely to have a teacher give heavy emphasis to "reasoning skills needed to solve unique problems."

Hence, according to previous NAEP data, black and Hispanic students were more likely than white students to be tested on finding the single correct answer to problems (on a multiple choice test) without the use of a calculator, which suggests basic fact computation as a major instructional focus. These differences are reminiscent of those revealed in Anyon's (1981) study, in which lower-SES students were found to receive more drill-based instruction, whereas higher-SES students were taught problem solving and reasoning skills. Other scholars (Ladson-Billings, 1997; Means & Knapp, 1991) have made similar observations about the tendency for black children to receive more traditional, drill-based instruction focusing on basic computational skills.

However, the question remains whether these race-related differences still exist in 2000, as well as how these differences relate to SES. Previous publications have tended to report on NAEP data using the isolated categories of "race" and "parent education level." Some authors have acknowledged the conflation of race and SES and have called for further research that would help separate these factors. For example, Strutchens and Silver (2000) noted, "Because black and Hispanic students are over-represented in low-income categories. . .[it is] difficult to untangle matters of race/ethnicity and economic conditions in these NAEP findings." (p. 51) They caution that the race-related differences in NAEP data might be due to SES more than race. Hence, previous NAEP reports raise, but do not address the question of whether race-related mathematics achievement gaps are primarily attributable to SES differences or to other factors, such as access to quality mathematics instruction.

Consistent with this trend, the most recent NAEP report for the 2000 main mathematics assessment provides general information about overall trends in mathematics achievement and instructional practices during the past decade (Braswell, Lutkis, Grigg, Santapau, Tay-Lim, & Johnson, 2001). This report also highlights several variables that correlate with achievement. For example it notes that 8th graders with unrestricted access to calculators scored significantly higher than their peers without such access. Similarly,

the report states that 4th, 8th, and 12th grade students who agreed with the statement, "Learning math is mostly memorizing facts," scored significantly lower than students who disagreed with the statement (Braswell et al., 2001, pp. 179-181). Still, it is important to consider the role of race and SES in these correlations, and examine whether such correlations might be due to continuing disparities in low-SES and minority students' access to reform-based practices.

Now that the 2000 mathematics data are available, enabling examinations of data points that mark the beginning, middle and end of the first wave of *Standards*-based reform, the time is ripe for a thorough examination of mathematics practices and outcomes as assessed by NAEP. This study goes beyond previously published reports on NAEP by closely examining race-related achievement gaps, giving attention to interactions among race and SES. In particular, the following four questions are addressed:

1) How have mathematics achievement gaps involving white, black and Hispanic students changed over the past decade?
   (Note: Analyses of race compare White, black and Hispanic students only. This relatively narrow focus is due to concerns about NAEP sample sizes for other ethnic groups when combining race and SES variables)

2) Are current race-related achievement gaps consistent across SES and gender groups? To what extent are race-related gaps attributable to SES differences that correlate with race?

3) Are reform-based instructional practices reaching all students, regardless of race?

4) For those instructional practices being implemented more with white students than with black or Hispanic students, to what extent do student- and school-SES account for the instructional disparities?

To address these questions, this study utilizes NAEP data to investigate patterns in students' mathematics performance and instruction. However, it is important to note that the NAEP is not longitudinal nor designed for making cause-and-effect inferences

regarding instructional methods and student outcomes. Still, identifying instructional factors that do and do not correlate with race-related achievement gaps can enrich our understanding of students' experiences with learning mathematics and can suggest important areas for further study. Additionally, while not assuming that instruction-related variables are the only, or even primary, cause of achievement gaps, it is important to give attention to the area that educators are best positioned to address.

METHOD

The Samples

The data used in this study are from the 1990, 1992, 1996, and 2000 main NAEP mathematics assessments. Data regarding 4th, 8th, and 12th grade mathematics achievement were included, as well as data from surveys administered to all participating students and their teachers. (Teacher data are for 4th and 8th grade students only — 12th grade teachers are not surveyed due to the large numbers of 12th graders not taking mathematics courses). 1990 samples consisted of 8,072 students, divided fairly evenly among the 4th, 8th, and 12th grades. Samples for 1992 and 1996 were much larger, each totaling about 21,000 students. In 2000 sample sizes doubled, totaling over 42,000 students. Achievement and survey data from the Main NAEP Mathematics assessments were accessed from the restricted-use CD ROM (containing 2000 data), as well as NAEP's web-based data tool, accessed at http://nces.ed.gov/nationsreportcard/naepdata/search.asp.

The Variables

Variables included in this analysis were those that pertained to students' mathematics achievement, student demographics, and instruction, very broadly defined to include factors that characterize or are likely related to the instruction students receive. Such factors included students' course-taking practices, students' attitudes toward mathematics, as well as teachers' instructional practices, curricular emphases, and educational backgrounds.

Student race. From students' self-reports (or when this information is missing, school records), NAEP categorizes students' race as one of the following: white, black, Hispanic, Asian/Pacific Islander, and American Indian (including Alaskan Native). For the equity-monitoring purposes of this study, the achievement of black and Hispanic students was compared to that of white students, with attention given to the interaction between race and SES. NAEP samples for American Indian & Asian students were generally too small to be used in comparisons involving race and SES and were therefore not analyzed.

Student SES. Over the past decade, NAEP has utilized several variables relating to students' SES. In 1990 and 1996, parent education level and literacy resources in the home (books, encyclopedia, magazines, and newspapers) were used as SES measures at each grade level. In 1996 free/reduced lunch eligibility was introduced and used again in 2000. Additionally, parent education level was no longer used in 2000 at the 4th grade level, due to concerns about obtaining accurate student self-reports of this information.

The shifting nature of SES-related variables makes it difficult to examine SES-related trends over the past decade. Hence, discussions of trends will focus primarily on race, with more in-depth discussions of interactions between race and SES focusing primarily on the 2000 data.

In order to examine SES interactions with race, it was desirable to create a powerful SES variable that would encompass multiple aspects of students' SES. After consideration of the much-debated meanings of "socioeconomic status" and "social class" (e.g., Duberman, 1976; Secada, 1992; Weis, 1988; Zweig, 1991), as well as consideration of the variables available in the NAEP 2000 data, a more comprehensive SES variable was created using factor analysis. In 8th and 12th grades, eight variables were combined to produce the new student SES variable: types of reading material in students' homes (newspapers, magazines, books, and encyclopedia)[4], computer and internet access at home, extent to which studies are discussed at home, school lunch and Title 1 eligibility, and education level of mother and father. Parent education levels were not reported for fourth graders in 2000, so the student SES measure at 4th grade involved only the remaining 6 variables.

Students who were missing more than 2 of the variables were deleted from consideration (resulting in .5% of the sample deleted at 4th grade, 5.6% at 8th grade, and 2.8% at 12th grade).

Principal components extraction at each grade level was followed by Varimax rotation, to achieve a tighter fit of each item to the resulting factors. The Kaiser-Meyer-Olkin measure of sampling adequacy was .694 at 4th grade, .764 at 8th grade, and .736 at 12th grade. At each grade level, the factor analysis produced two factors each with eigenvalues greater than 1, with one factor more heavily loaded on Title 1 and lunch eligibility, and the other more heavily loaded on the remaining home environment variables. The factors were saved as variables using the Anderson-Rubin method, which results in a composite Z-score with mean zero and standard deviation one. Given that the goal was to distill a single SES variable, a linear combination of the two factors was constructed using the eigenvalues as weights. (For example, if one factor had an eigenvalue of 1 and the other had an eigenvalue of 2, the factors were combined using the equation: New Variable = 1/3 * variable 1 + 2/3 * variable 2.)

Given this method of creating the new SES variable at each grade level, there were differences across the three grade levels in the weights used to construct the composite SES variables (and differences in the structure of the variables themselves, given that parent education was not available at 4th grade). However, what remained consistent was the desire to produce as strong an SES variable as possible within each grade. (A linear regression analysis of the SES variable with achievement produced adjusted r-squares of .25 at 4th grade, .24 at 8th grade, and .22 at 12th grade.)

Once the SES variable was created at each grade level, SES quartiles and halves were created and utilized in the analyses reported here. Each SES quartile contained roughly 25% of the weighted sample of students, although this percentage varied by race (see Figure 1.) Higher proportions of white students were in the higher SES levels, whereas higher proportions of black students were in the lower levels.

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[4] Students report whether they have each of these items, and then NAEP combines the four responses into

INSERT FIGURE 1

School SES. A school administrator at each sampled school completed a survey requesting information about the school, including the percentage of students qualifying for Title 1 funds and free/reduced lunch. For the purposes of this study, these two variables were averaged to produce a single school-SES variable. Quartiles were then created and utilized in the analyses reported here. Each school SES quartile contained roughly 25% of the weighted sample. Greater proportions of white and higher-SES students were in the higher SES schools. The data speaks to the stratification of schools by student-level SES in that remarkably few high-SES students of any race were in low-SES schools, and conversely, very few low-SES students of any race attended high-SES schools (see Table 1 for unweighted sample sizes by school SES).

INSERT TABLE 1

Data Analysis

There are several features that complicate the analysis of NAEP data. These features include the use of multi-staged, stratified random sampling (in which geographic areas, then schools and then students are selected), the oversampling of private school and minority students, and the use of plausible values to estimate scores for each student based on his/her background and performance on a subset of items.

NAEP's web-based data tool was used to derive basic race-related trends across the 1990, 1992, 1996 and 2000 mathematics achievement and student/teacher survey data. In this analysis, the crosstabulation feature of the NAEP data tool was used to calculate means and standard errors for student achievement data, as well as student and teacher questionnaire data. Specifically mathematics achievement means and instruction-related data were compared for white, black and Hispanic students, with an eye toward changes in gaps between 1990 and 2000. Not only were overall means compared, but performance differences in each of the five mathematical strands were examined.

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a single variable, with categories of 0-2 items, 3 items, or 4 items.

To calculate an achievement mean, the tool calculates the mean for each of the five plausible values across students in the sample, and then averages the five means. When making sampling variance estimates, 62 replicate weights are used for each student, with standard errors calculated using the jackknife repeated replication approach. Measurement error is calculated as the variance of the five plausible values. Then the overall variance estimates combine both the sampling variance and measurement error. Because sampling procedures create unequal probabilities for student selection into the sample, the tool also utilizes sampling weights in its analyses of both achievement and student/teacher survey data. A student's overall sampling weight is the reciprocal of his/her probability of being selected. For more information about these statistical procedures, see Johnson (1992) or Johnson and Rust (1992).

The general analysis of race-related differences conducted with the web-based tool revealed several significant race-related differences in achievement and instruction. The raw, restricted-use 2000 NAEP data were then utilized to examine the gaps more closely, to determine the extent to which these race-related differences persisted within and across SES groups. Crosstabulation tables involving race, student-SES quartiles, and achievement and instructional variables were created to examine these patterns. The purpose of these analyses was to determine which race-related differences in instruction persist after controlling for student SES, and, therefore, could be factors underlying race-related gaps in achievement that persist after controlling for student-SES.

To a lesser extent, school-SES was considered in conjunction with both race and student-level SES, to examine the extent to which school-SES differences could account for the race-related differences in achievement and instruction that persist after accounting for student-level SES differences. Again, crosstabulation tables were utilized in these exploratory analyses. However, due to small sample sizes that result when examining these three variables in conjunction with one another, the school-SES analyses are reported in very limited ways here.

Overall, the analyses reported here focus on descriptive statistics that lay the ground work for analyses of race-related differences that persist across school- and student-level SES groups. Specifically, the next step in this research is to utilize Hierarchical Linear Modeling (HLM) to determine the relative strength of the correlation between various

demographic variables (e.g., race, student SES and school SES) and student achievement, in conjunction with particular instructional practices. Such analyses will determine, for example, whether calculator use correlates positively with achievement for all groups of students after controlling for race, student SES and school SES.

RESULTS

This section begins by discussing race- and SES-related mathematics achievement disparities, including trends between 1990 and 2000. The focus then turns toward instruction-related issues.

Overall Mathematics Achievement: 1990-2000

Despite the concerns about equity raised by this study, it is important to note the good news: NAEP scores increased between 1990 and 2000 for white, Hispanic and black students and for both low- and high-SES students (Braswell, Lutkis, Grigg, Santapau, Tay-Lim, & Johnson, 2001). However, substantial gaps remain, and some appear to be growing.

In order to help the reader interpret the results discussed here, some information about NAEP scores is necessary. NAEP uses a consistent 500 point scale on which 4th graders scored an average of 228, 8th graders scored 275 and 12th graders scored 301 in 2000. Hence, an achievement gap of 9 points can be considered, in very rough terms, a one-year difference. (9 points would be slightly less than one year at the elementary level and more than one year at the secondary level).

INSERT TABLE 2

The 2000 data reveal the persistence of large achievement disparities, with white students significantly[5] outscoring their black and Hispanic counterparts. As Table 2 reveals, the 2000 Hispanic-white gap was 24 points at fourth grade, 33 points at 8th

grade (up 7 points from 1990), and 25 points at 12th grade. The 2000 black-white gap was 31 points at fourth grade, 39 points at 8th grade (up 7 points from 1990), and 34 points at 12th grade. These data suggest that the middle grades are a critical time for the growth of both black-white and Hispanic-white gaps over the past decade. Overall, Hispanic-white gaps are large but less severe than black-white gaps. Still, the magnitude of both Hispanic-white and black-white gaps is great in comparison to the 3-4 point gender gaps that exist at 4th, 8th and 12th grade.

Another way to put some perspective on the severity of these race-related differences, is to examine Figure 2, which highlights that the achievement of white 4th graders is closer to the achievement of black and Hispanic 8th graders than black and Hispanic 4th graders. Moreover, we can see that in 1990, 12th grade black students scored similarly to 8th grade white students, but in 2000, the 8th grade white students scored a significant 8 points higher than 12th grade black students. The NAEP scale is designed to make these cross-grade comparisons. These data do imply that, on average, black students are leaving high school with less mathematical knowledge than white 8th graders possess, at least as measured by the NAEP assessment.

INSERT FIGURE 2

One might wonder if these gaps are primarily due to socioeconomic differences. Lubienski's (2002a; 2002b) preliminary analysis using free/reduced lunch eligibility as an SES proxy showed that lunch-eligible white students outscored wealthier non-eligible black students at each grade level. Hence, in this analysis, race-related differences seemed largely unattributable to SES differences that correlate with race. However, the race-related pattern weakens to some extent when a stronger SES variable is used.

Table 3 reveals that SES-related disparities in achievement are large, with gaps between the means for students in the lowest- and highest-SES quartiles, ranging from 25 to 35 points within each racial group. Hence, the SES related gaps are similar in size to the 24-39 point race-related gaps noted in Table 2 above. However, SES related differences do not account for substantial portions of the race-related gaps as evidenced

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[5] Significance tests reported in this article are two-tailed tests, using .05 as the critical p value.

by the 10-19-point White-Hispanic gaps and 17-31-point White-Black gaps within each SES category. Additionally, one can see, for example, that the lowest-SES white 12th graders score more similarly to the highest-SES Black students (3-point gap) than to their lowest-SES black counterparts (22-point gap).

INSERT TABLE 3

A Closer Look at 2000 Performance: Mathematical Strands

In accordance with NCTM's curricular emphasis on five mathematical strands, NAEP assesses student achievement in each of those strands: number, data analysis, algebra, geometry, and measurement. Overall student performance varied only slightly by strand (see Table 4). However an exploration of race-related gaps on each mathematical strand revealed several patterns.

INSERT TABLE 4

Hispanic-white gaps were largest in measurement at the 4th and 12th grade levels (see Figure 3). However, the largest disparities across the strands occurred in 8th grade, where data analysis had the largest gap (49 points, as opposed to measurement's 44 points).

INSERT FIGURE 3

The black-white gaps were largest in measurement for all three grade levels, with data analysis/statistics taking second place (see Figure 4). This continues a pattern noted in 1990 and 1996 (Lubienski, 2001). The pattern was most striking in 8th grade, where the 2000 gap for measurement was 58 points, up 19 points from 1990. Black-white gaps were smallest in Algebra at 4th, 8th and 12th grades, whereas Hispanic-white gaps were smallest in Algebra at 4th grade, geometry at 8th grade, and both algebra and geometry at 12th grade.

INSERT FIGURE 4

Searching for Explanations -- Mathematics Instruction and Related Variables

The NAEP is not longitudinal nor designed for making cause-and-effect inferences regarding instructional methods and student outcomes. However, analyses of NAEP student and teacher questionnaires can reveal similarities and differences in students' classroom experiences and attitudes, thereby shedding light on factors that could shape the achievement differences noted above.

As outlined above, Strutchens and Silver (2000) summarized 1996 NAEP data pertaining to race-related patterns in students' beliefs and school experiences. They identified several aspects that differed between black and white students, including beliefs about mathematics involving single solution paths and fact memorization, uses of technology, teacher emphasis on reasoning, and student course taking. In the section that follows, these and other factors are examined, going beyond Strutchens and Silver's race-focused analyses in two ways. First, race-related disparities in instruction that they identified in 1996 data are examined to see if they persist in the 2000 data. Second, because of the severity of black-white achievement differences even after controlling for SES, black-white differences in instruction are examined in conjunction with student SES.

Student beliefs

Student beliefs are related to both the instruction they receive and their mathematics achievement (although the causal direction involved is generally not clear). As noted previously, Strutchens and Silver (2000) reported many similarities across white, Hispanic and black students' attitudes toward mathematics, with Hispanic and black students being at least as likely as white students to report liking mathematics, and believing "everyone can do well in mathematics if they try." They found no consistent patterns that correlated with achievement in terms of students' feelings of confidence in mathematics, and believing that mathematics is useful. However, there were two beliefs for which race-related differences were found. Black and Hispanic students were more likely than white students to agree with the statements, "There is only one correct way to solve a math problem" and "Learning mathematics is mostly memorizing facts."

The 2000 data reveal similar patterns with no major changes in the numbers since 1996 (the question was not asked before 1996). Race-related differences persisted in relation to both students' beliefs about single solutions to mathematics problems and mathematics learning as memorization.

"There is only one correct way to solve a math problem." As in 1996, the majority of students assessed in 2000 expressed disagreement with the idea that there is only one correct way to solve math problems, but again the percentages varied by race at grades 4 and 8. Only 13% of white 4th graders and 7% of white 8th graders indicated agreement with the statement. However, these percentages were roughly double for black and Hispanic students. (See Table 5). It is sensible to ask whether these disparities were primarily due to SES differences that correlated with race. As Table 5 shows, more low-SES white and black 4th and 8th graders agreed with the statement than their high-SES counterparts, however, race-related differences persisted within each SES group. For example, more than twice as many high-SES Black 4th graders (21%) as High-SES White 4th graders (10%) agreed with the statement.

INSERT TABLE 5

"Learning mathematics is mostly memorizing facts." Less than half of white 4th graders and less than a third of white 8th and 12th graders viewed learning mathematics as fact memorization, but these percentages were roughly 60% for black and Hispanic 4th graders, 55% for black 8th and 12th graders, and about 48% for Hispanic 8th and 12th graders The analysis of race and SES together revealed that race-related differences persisted within each SES category, with low- and high- SES black students holding this belief more than their white counterparts. Although, on average, students moved away from this belief as they progressed through school, the black-white gaps increased at the upper grade levels, largely because the percentage of low-SES black students agreeing with the statement did not decrease in the upper grades, as occurred with their more advantaged peers.

Although a definitive determination of the causes underlying these belief differences is beyond the scope of this paper, one likely factor is the nature of mathematics instruction students receive. The following sections explore differences in mathematics instructional practices encountered by black, white, and Hispanic students.

Instructional practices

NAEP data reveal many similarities in white, Hispanic, and black students' classroom experiences, as reported by both students and their teachers. In their analysis of 1996 data, Strutchens & Silver (2000) found that the use of manipulatives, the use of "real-life" mathematics problems, student collaboration, student writing, and time spent on mathematics instruction do not correlate with race-related achievement gap differences. However, other instructional differences were found to correlate with achievement gaps, including the use of calculators, computers, and multiple choice tests.

This study examined 2000 data in each of these areas and found similar patterns in most areas. (Again, these analyses focused on teacher survey data from 4th and 8th grades only, because 12th grade teachers are not surveyed.) The 2000 data were also examined to determine the extent to which race-related differences persisted within each SES category.

Calculator Use

Since 1990, NAEP has asked teachers how often they allow students to use calculators both in the mathematics classroom and on tests. These data indicate that classroom calculator use dramatically increased between 1990 and 1996, suggesting that the mathematics curriculum moved away from a primary focus on computational skills. For example, in 1990 only 12% of 8th grade students had teachers who reported that students used calculators "almost every day." By 1996, this percentage had leaped to 55%, and has since come down slightly to 48%. However, these trends differed by student race.

Throughout the past decade, white eighth graders were allowed more access to calculators for daily use (see Figure 5) and on tests (see Figure 6) than were Hispanic or black students. White and Hispanic students' calculator use actually decreased between 1996 and 2000, while black students' use continued to increase, which helped to narrow

some gaps. However, white eighth graders remain significantly more likely than black or Hispanic eighth graders to have regular access to calculators for daily use and tests.

INSERT FIGURES 5 AND 6

Again, one might wonder whether gaps in calculator use correlate more closely with SES or race. Further analyses of race and SES together reveal that large portions of the race-related differences were not attributable to student SES differences. There were substantial race-related gaps within each SES category, with both low- and high-SES white students having more calculator access than their respective black and Hispanic peers. Moreover, the highest SES black students were allowed less calculator access than the lowest-SES white students. (See Table 6)

INSERT TABLE 6

It is sensible to wonder to what extent school-level SES is a factor in this, since a larger portion of high-SES Black and Hispanic students than high-SES White students attend low-SES schools. An exploration of race, student SES and school-level SES together indicate that even within low-SES schools, low-SES white students are given more calculator access than their low-SES Black and Hispanic peers. Tracking practices within schools is likely a factor in these differences, causing different instructional practices to be used with white students than with their black and Hispanic peers.

Computer Use

According to teacher reports, black and Hispanic students had at least as much computer use in their mathematics classrooms as did white students. However, there were some differences in the ways in which this technology was used, particularly at the 8th grade level. (See Figure 7.) More teachers of black students than white or Hispanic students reported that instructional computer use was primarily for drill and practice and games. Fewer Hispanic students than white or black students saw computers used for simulations, applications or demonstrations of new topics. Because the differences noted are small and somewhat inconsistent, these differences are not examined further by SES.

INSERT FIGURE 7

Multiple Choice Tests

Contrary to what one might expect given the current NCTM reforms (but consistent with other policy trends such as No Child Left Behind), multiple choice test use increased between 1996 and 2000. (See Figure 8.) The percentage of students whose teachers reported using multiple choice assessments at least once or twice a month jumped from 48 to 60 for 4th graders and 34 to 44 for 8th graders between 1996 and 2000. However, the percentages continue to vary widely by race. The disparities were particularly large at the 8th grade level, where 63% of black students, 44% of Hispanic students and 38% of white students were assessed with multiple choices tests at least monthly.

INSERT FIGURE 8

Analyses of race and SES together revealed that 4th grade black students of all SES levels were more likely than white students to be assessed with multiple choice assessments. Specifically, high-SES white (53%) and Hispanic (62%) 4th graders were less likely to have multiple choice tests than their low-SES counterparts (64% white, 73% Hispanic), but SES patterns were absent for black 4th graders, with 68% of black students at each SES level encountering multiple choice tests at least monthly. However, at the 8th grade, differences were more closely tied to SES than race. For example, whereas 69% of low-SES black students were assessed with multiple choice tests at least monthly, this percentage was only 42% for high-SES black students.

These differences in student assessment suggest that white students might gain more experience with open-response assessments than do Hispanic or black students. Hence, these differences could relate to the fact that omit rates are higher for Hispanic and black students than white students on NAEP's open-ended assessment items. Race-related performance gaps are particularly large for these items as well. (See Strutchens and Silver, 2000)

Teacher emphases

As part of the NAEP teacher survey, 4th and 8th grade teachers were asked about the emphasis they place on each of the five mathematics content strands, as well as four additional topics: facts and concepts, skills and procedures needed to solve routine problems, reasoning skills for solving unique problems, and communication of mathematical ideas. The scale teachers were given to indicate their emphasis on each topic consisted of four options: "A lot of emphasis," "some emphasis," "a little emphasis," or "no emphasis". Overall, there was remarkable consistency across both student race and SES in terms of the emphasis teachers reported giving to most topics, and what patterns did exist tended to correlate inversely from what might be expected given achievement trends. Most notably, despite the large gaps in measurement achievement, teachers of white 8th graders actually report emphasizing measurement slightly less than teachers of black and Hispanic 8th graders. For example, 20% of white 8th graders had teachers who reported giving only "little emphasis" to measurement, in contrast to 12% for black and Hispanic students.

In 1996, the most marked differences in the teacher emphasis data involved 8th grade teachers' reported emphasis on reasoning skills for solving unique problems, with white and Hispanic students more likely than black students to have teachers who reported giving substantial emphasis to this topic. However, in 2000 the gaps were closed.

Teachers were also asked how prepared they felt to teach each of the 5 strands, as well as how prepared they felt to use manipulatives and to teach estimation, computers, and problem solving. There were no significant differences favoring white students in any of these areas.

Still, meaningful differences might be masked in these data on teacher emphases and preparedness. The three-four point scale used on the teacher survey items is rough and perhaps insensitive to actual differences in teacher emphases or feelings of preparedness. Also, the NAEP surveys do not distinguish among the many topics within each mathematics strand.

Teacher educational background

Teacher knowledge of the NCTM *Standards* increased slightly for all groups between 1996 and 2000, with gains greater at the 4th than 8th grade level. In 2000, 63% of fourth graders and 87% of eighth graders had teachers who reported being at least "somewhat knowledgeable" about the NCTM *Standards*. Variations across race- and SES-related subgroups were small and not statistically significant.

INSERT TABLE 7

One might wonder if differences in teacher instructional practices are rooted in differences in teachers' academic preparation. To explore this conjecture, differences in the educational backgrounds of 4th and 8th grade teachers were examined (again, teacher surveys were not administered to 12th grade teachers.)

The percentages of black, white and Hispanic students whose teachers held masters' degrees, were certified in their fields, spent time in mathematics education workshops, or had taken particular mathematics education or mathematics content courses were examined. No significant race- or SES-related differences were found at the 4th grade level. One difference was identified involving teacher certification at the 8th grade level. Whereas only 80% of white 8th graders had teachers who were not certified in secondary mathematics education, only 72% of Hispanic and black 8th graders had such teachers. (See Table 8.)

INSERT TABLE 8

On average, eighth grade students whose teachers were certified in secondary mathematics scored a significant 14 points higher on the NAEP mathematics assessment than those students whose teachers were not certified in secondary mathematics education. However, caution must be exercised in concluding that differences in teacher backgrounds are causing these achievement differences. These differences in achievement between students of certified and non-certified teachers do persist within each race and SES category, but the causal direction could be reversed. That is, higher achieving eighth graders are often tracked into more advanced courses, which are more likely to be taught by teachers certified in mathematics.

Overall, there were remarkably few differences in teacher background, according to the NAEP measures. However, it should be noted that NAEP's basic measures of teacher course taking and degrees earned do not indicate how well teachers mastered the subject matter in those courses. Other evidence (e.g., Ferguson, 1998c) suggests that black students are more likely to have teachers who score lower on teacher competency tests.

Student course taking

NCTM promotes a core secondary mathematics curriculum, with all students taking mathematics throughout their high school careers. NCTM argues that all students need a mathematical foundation that will allow them access to a wide range of future opportunities, including advanced study of mathematics. Perhaps the most important factor that determines whether high school students gain a solid mathematics foundation is student course-taking. Differences in the courses students take can shed light on race- and SES-related gaps in secondary mathematics achievement.

In 2000, more white students than Hispanic or black students took geometry, algebra II, pre-calculus and calculus (see Figure 9). For example, the percentage of students taking geometry were 84%, 71% and 74% for white, Hispanic and black students, respectively. Gaps were similar for algebra II/trigonometry, and pre-calculus. Gaps were slightly smaller for calculus, with slightly more Hispanic students taking calculus than black students.

INSERT FIGURE 9

A closer examination of race-related course-taking gaps in conjunction with student and school SES reveals that such gaps are tied more closely to SES than to race. For example, while 10% of White students reported having taken AP Calculus (AB and/or BC), this percentage was 7% for Hispanic students and 6% for Black students (see Table 9). (Although beyond the scope of this paper, it is interesting to note that 26% of Asian students reported taking AP Calculus.) However, there were no differences between low-SES Black and White students (4%) in terms of AP Calculus course taking, with relatively small gaps among high-SES White, Black and Hispanic students. Hence, race-related differences did not strongly persist within SES categories. Additionally, while only 6%

of students in low-SES schools took calculus, compared with 16% for high-SES schools, low-SES White students in low-SES schools (2%) were actually less likely to have taken AP Calculus than their low-SES Hispanic(5%) and Black (4%) peers in lower-SES schools. Meanwhile, 12% of high-SES white students took AP calculus in lower-SES schools (compared with 22% of high-SES white students in high-SES schools). Hence, both student- and school-level SES appears to play a role in calculus course taking, with SES differences accounting for most of the race-related gaps in course taking. (These patterns are consistent with those found in 1996 as well. See Lubienski, 2002).

INSERT TABLE 9

In general, course taking differences leave race-related achievement gaps largely unexplained. Achievement gaps shrink between 8th and 12th grades, instead of enlarging as one would expect if course taking differences played a primary role in achievement gaps. (Still, the fact that there are course taking differences at the 8th grade level, and the fact that high school "drop outs" are not surveyed at 12th grade needs to be considered in interpreting these data). Another way in which the limited explanatory power of course taking is revealed is through comparisons of those students who reported taking the same courses. For example, 14% of white students reported taking calculus in 12th grade, compared with 5% of black students and 6% of white students. But the score gaps for these calculus students were again severe, with the white students scoring 344, black students scoring 314 and Hispanic students scoring 318. It is worth noting that these black and Hispanic calculus students did score higher than the overall white average of 308. However, they lagged far behind their white calculus-taking peers. Hence, course taking is a factor that correlates with achievement gaps, but it leaves much of the race-related gaps unexplained.

DISCUSSION

After a decade of reform intended to change mathematics instruction, increase mathematics achievement, and reduce inequities, much work remains. NAEP data indicate

that major shifts in instruction have occurred. For example, in 1990, only 32% of 8th graders had teachers who permitted the use of calculators on tests. That percentage was doubled in 2000. Additionally, mathematics achievement increased significantly for white, black and Hispanic students of both low and high SES between 1990 and 2000. However, inequities in mathematics outcomes have not improved. In fact, the inequities have increased at the 8th grade level.[6] Particularly disturbing is the fact that the performance of black 12th graders was lower than that of white 8th graders.

These results raise the question of how these gaps in performance can be explained. It should be noted that even when gaps appear to be rooted in "SES" differences, such differences do not actually "explain" the gaps (Secada, 1992).[7] But black-white gaps that persist after considering SES raise further questions about explanatory factors. In recent years, many researchers have struggled to understand underlying causes of race-related achievement gaps. Clearly, SES differences involving parent education, occupation, income, and educational resources in the home account for much of these gaps (Jencks & Phillips, 1998; Peng, Wright, & Hill, 1995). Other scholars have considered the role of teacher expectations, school structure, student motivation, and student resistance (e.g., Banks, 1989; Cook & Ludwig, 1998; Ferguson, 1998a; 1998b; Ogbu, 1995; Steele & Aronson, 1998). These discussions have tended to focus on the overall academic performance and experiences of students, as opposed to an in-depth examination of achievement and instructional practices in a particular subject area. By looking in depth at how achievement gaps vary by mathematical strand, and by examining disparities in students' access to reform-based mathematics instructional practices, this study sheds new light on potential factors underlying achievement gaps — factors over which educators and policy makers have control.

Student course taking appears to be one factor underlying gaps at the secondary level. However, given that students generally take the same courses in elementary school, and

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[6] NAEP trends must be considered in the context of other research, such as a recent TIMSS report that indicated a narrowing of the black-white gap for 1999 8th graders, (when compared with 4th graders tested four years earlier), and a widening of gaps relating to parental education (US Department of Education, 2001). Other authors have warned that black-white gaps in mathematics and other subject areas have widened over the past decade (e.g., Lee, 2002; Jencks & Phillips, 1998).

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given that course taking differences appear more closely tied to SES than race, such differences leave much of the race-related achievement gaps unexplained.

This study looked beyond which courses students were taking, and examined the instructional practices occurring within students' mathematics classrooms. There are several aspects of students' beliefs and classroom experiences that do not correlate with achievement disparities. For example, black and Hispanic students were at least as likely as white students to report liking mathematics. Additionally, there were few consistent SES- or race-related gaps found in the use of manipulatives, "real-life" mathematics problems, writing in mathematics class, student collaboration, and time spent on instruction. Moreover, no significant differences were found in teachers' reported knowledge of the NCTM Standards, their reported emphasis on many central tenants of the Standards, and their feelings of preparedness to teach the content strands outlined in the *Standards*.

However, this study identified several instructional differences that could relate to achievement disparities. First, the wide variation in the 8th grade race-related gaps across the strands suggests that curricular variation across schools and classrooms might underlie some portions of these gaps. For example, white 8th graders scored a full 59 points higher (roughly 6 grade levels) in measurement than black 8th graders. Additionally, there were race- and SES-related differences in students' beliefs that there is only one correct way to solve a mathematics problem and that mathematics learning is primarily fact memorization. Additionally, black and Hispanic students had less access to calculators in mathematics classrooms and were more often assessed with multiple choice tests. These data indicate ways in which white and high-SES students were more likely than their less advantaged peers to be receiving *Standards*-based instruction. Additionally, the examination of race/class interactions indicated that the instructional differences between black and white students persisted after accounting for student SES.

Although the instruction-related differences identified might appear minor when compared with the many similarities reported in classroom practices, these differences in

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[7] Secada raises the important point that researchers tend to "control" for SES and then seek no further explanations for SES-based differences. Additional research is needed to understand the many home- and school-related factors that underlie SES-related achievement differences.

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both student beliefs and experiences suggest a consistent pattern of lower-SES, black, and Hispanic children tending to be taught and assessed with an emphasis on low-level skills. Again, such differences align with those found by Anyon (1981) in her examination of social class and differences in instructional/curricular practices. However, this study indicates that such differences in practice are related to students' race as well as their SES, with high-SES black students likely to encounter many of the practices that low-SES students generally encounter. This provides evidence that, almost 50 years after *Brown v Board*, schools continue to employ unequal educational practices with students on the basis of race, in addition to SES.

Limitations

There are several limitations of this analysis. First, as mentioned previously, the SES variable used in this study relies on students' self-reports of parent education and resources in the home. SES-related trends across grade levels should be viewed with caution both because self-reported data is likely more reliable for 12th graders than 4th graders, and also because information regarding parent education level was not available at 4th grade. Other limitations of the SES variable used in this study include its exclusion of information regarding parental occupation and income (beyond lunch eligibility). This, in conjunction with census data indicating different income distributions for white, Hispanic, and black populations (U.S. Census Bureau, 1998), implies that within-SES group comparisons among white, Hispanic, and black students must be interpreted with care. That is, although some white, Hispanic, and black students were classified together as "low-SES" or "high-SES" in this study, there were likely substantial SES-related differences between them that a more sensitive SES variable would expose. Hence, when variables appear to be more related to race than SES, one must consider that a stronger SES variable might strengthen the SES relationship.

Another caveat to note is that NAEP classroom practice data are based on teacher and student self-reports, and differences in question interpretations or perceived pressure to portray instruction in particular ways could have affected student and teacher responses to questions.

There are many facets not included in NAEP assessments that are likely important factors in shaping both instructional practices and achievement gaps.

There are several factors that were beyond the scope of this article. Examples include class size, teachers' expectations of students, teachers' involvement with students outside of the classroom, and the many more subtle aspects of students' opportunities to learn mathematics (e.g., see Tate, 1995). Additionally, this study did not consider gender in conjunction with race and SES, because boys and girls who are sitting together in the same mathematics classrooms would presumably have roughly the same access to the same reform-based instructional practices. (This is not to say that more subtle forms of disparities in instruction are not occurring for boys and girls, but these aspects would be unlikely identified in the large-scale, self-reported NAEP data). Still, more detailed studies of achievement trends should consider interactions among race, SES and gender. Additionally, more in-depth, qualitative studies are needed to examine interactions among race, SES and gender in students' experiences in mathematics classrooms.

Finally, although white and higher-SES students appear to experience more of the instructional practices promoted by current reformers, one cannot conclude that these practices are the *cause* of their higher achievement. The instructional practices reported for each student are only those the student is encountering at the time the NAEP assessment is administered. Hence, students' experiences in previous years with other teachers are not reflected in the NAEP classroom practice data. One important potential confounding variable not examined in any depth in this study thus far is school-level SES. Our further examinations of NAEP data will attempt to clarify the role of school-level SES in the correlations among race and instructional practices.

Conclusion

Current reforms in mathematics education, led by the National Council of Teachers of Mathematics are intended to rectify past inequities by offering all students a mathematics education centered around mathematical problem solving and critical thinking. The gaps uncovered in this study suggest that white students—especially those of high-SES—are experiencing more of the fundamental shifts called for by NCTM. Such shifts involve teachers and students moving away from a conception of mathematics

learning as memorization and computational rule practice to one that emphasizes mathematical reasoning and understanding. The fact that disproportionate numbers of black and Hispanic students view mathematics learning as memorization suggests that these students are being left behind in the current reform movement.

This study raises but does not answer questions regarding the reasons for instructional differences between white and minority students, as well as between lower- and higher-SES students. One common explanation is that teachers have low expectations of black and lower-SES students and, therefore, emphasize only basic, low-level skills when teaching these students (Ferguson, 1998a). Yet perhaps a more complex interpretation should be considered. Administrative support for teachers, community expectations of teachers, and student resistance to particular instructional methods could all be factors in determining which students receive *Standards*-based instruction.

It could be, for example, that race- or SES-related differences in students' views about the role of memorization in learning mathematics initially stem from cultural differences, that teachers then adapt to and magnify through instruction. Indeed, some authors have discussed ways in which some students can have particular culture-based orientations to learning, most notably in literacy (Delpit, 1986; Heath, 1983) but also in mathematics (Lubienski, 2000a; 2000b). Such studies suggest that implementing reform-oriented curricula and pedagogies without attention to the particular strengths and needs of minority or low-SES students will not automatically narrow achievement gaps. However, more in-depth, sociocultural studies are needed to identify just what those strengths and needs are and how they might relate to current instructional trends.

With NCTM's (2000) recent affirmation of its vision of mathematical power for all, it is particularly important that researchers continue to monitor and seek to address inequities in both outcomes and instructional practices that relate to such outcomes. The NAEP offers one avenue for examining disparities in achievement, student/teacher attitudes, and classroom practices. The patterns identified in this study set the stage for a more thorough examination of the 2000 NAEP data utilizing HLM analyses.

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Figure 1: 2000 Percentages of white and black Students In Each SES Level

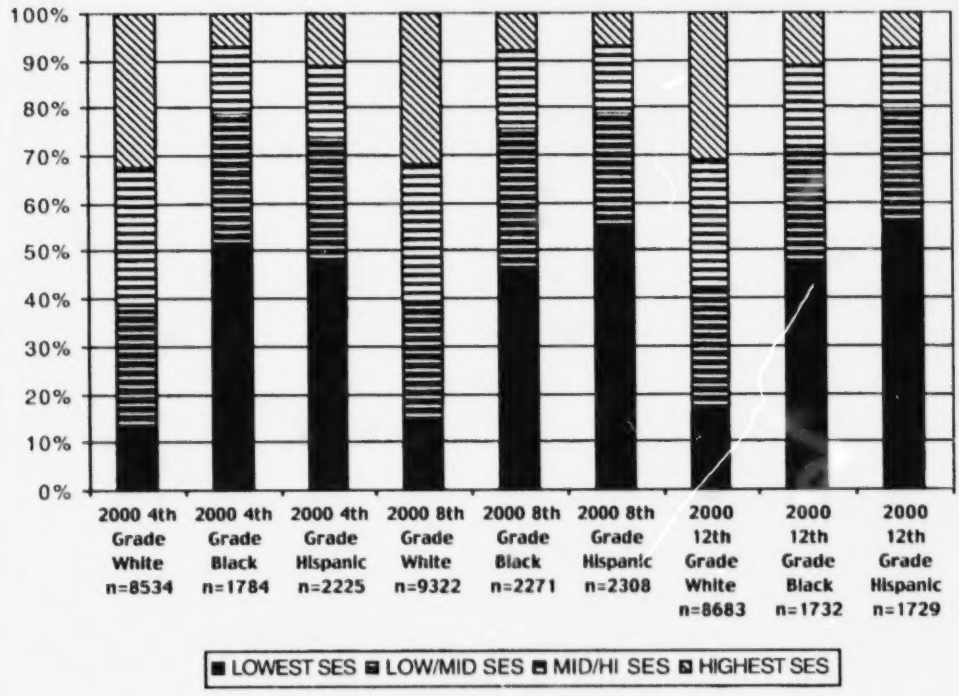

Figure Note: These are based on unweighted sample sizes. The small numbers of students who are missing SES information are not included in these counts (and therefore the numbers differ slightly than those in Table 2).

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Table 1: 2000 Unweighted Sample Sizes by Race, Student SES and School SES

	4th Grade		8th Grade		12th Grade	
	Lowest SES School	Highest SES School	Lowest SES School	Highest SES School	Lowest SES School	Highest SES School
White	703	4261	794	4117	754	4386
Low SES White	359	31	248	104	227	206
High SES White	13	2443	118	2206	132	2013
Hispanic	639	474	962	416	748	420
Low-SES Hispanic	456	7	621	48	497	50
High SES Hispanic	2	208	8	140	21	129
Black	726	235	965	254	631	282
Low SES Black	493	6	517	11	355	40
High SES Black	6	106	26	105	38	92

Table 2: 2000 Achievement By Race

	Fourth Grade	Eighth Grade	Twelfth Grade
Overall Achievement	228 *(0.9)* *n=13,511*	275 *(0.8)* *n=15,694*	301 *(0.9)* *n=13,432*
White Achievement	236 *(1.0)* *n=8581*	286 *(0.8)* *n=9673*	308 *(1.0)* ***n=8895***
Hispanic Achievement	212 *(1.5)* *n=2239*	253 *(1.5)* *n=2573*	283 *(2.1)* *n=1838*
Black Achievement	205 *(1.6)* *n=1795*	247 *(1.4)* *n=2449*	274 *(1.9)* *n=1813*
Hispanic/White Gap	24	33	25
Black/ White Gap	31	39	34
Change in White Ach. 1990-2000	+16	+16	+7
Change in Hispanic Ach. 1990-2000	+14	+9	+7
Change in Black Ach. 1990-2000	+16	+9	+6
Change in Hispanic/White Gap 1990 - 2000	+2	+7	0
Change in Black/White Gap 1990 - 2000	0	+7	+1

Table note: The sample sizes are based on the unweighted samples.

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Figure 2: Mathematics Achievement by Race, 1990-2000

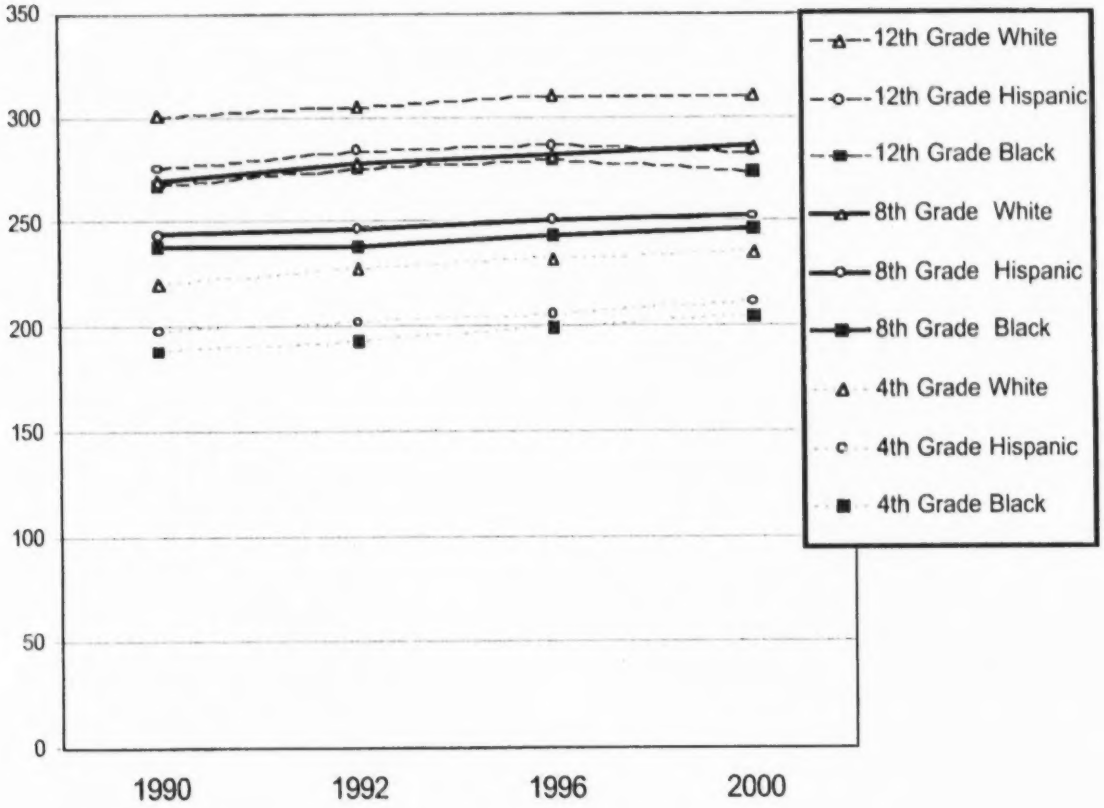

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Table 3: Mean Achievement by Race and SES, 2000

	Fourth Grade		Eighth Grade		Twelfth Grade	
	Lowest SES	Highest SES	Lowest SES	Highest SES	Lowest SES	Highest SES
White	215 14% (1.8)	247 32% (1.0)	266 14% (1.3)	300 32% (0.9)	289 16% (1.8)	323 31% (1.3)
Hispanic	202 48% (1.9)	237 11% (3.0)	247 55% (2.1)	281 7% (2.8)	276 56% (2.6)	310 8% (3.3)
Black	198 51% (1.7)	228 7% (3.2)	242 47% (1.6)	270 8% (2.5)	267 47% (1.9)	292 11% (2.8)
White-Hispanic Gap	13	10	19	19	13	14
White-Black Gap	17	19	24	30	22	31

Table note: The percents are row percents. For example, 14% of white 4th graders were in the lowest SES quartile. Standard errors are in parentheses.

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Table 4: Overall Achievement by Grade and Mathematical Strand, 2000

	Number	Data	Algebra	Geometry	Measurement	Mathematics Composite
4th Grade	225	230	232	227	228	228
8th Grade	276	278	277	272	273	275
12th Grade	296	301	303	304	300	301

Figure 3: 2000 Hispanic-White Gap in Achievement by Grade and Mathematical Strand

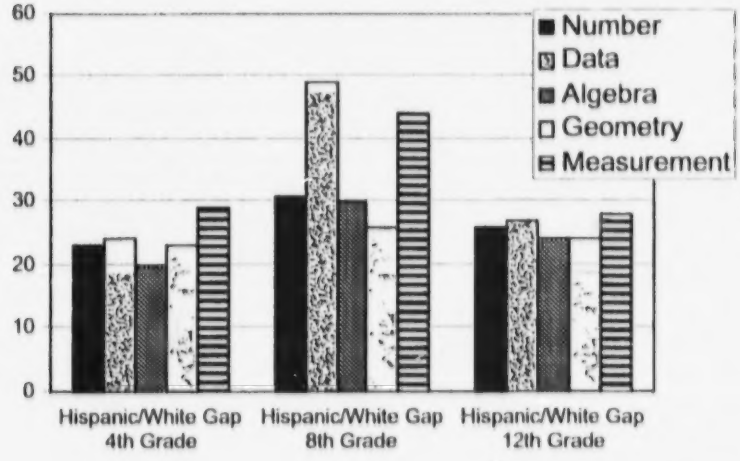

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Figure 4: 2000 Black-White Gap in Achievement by Grade and Mathematical Strand

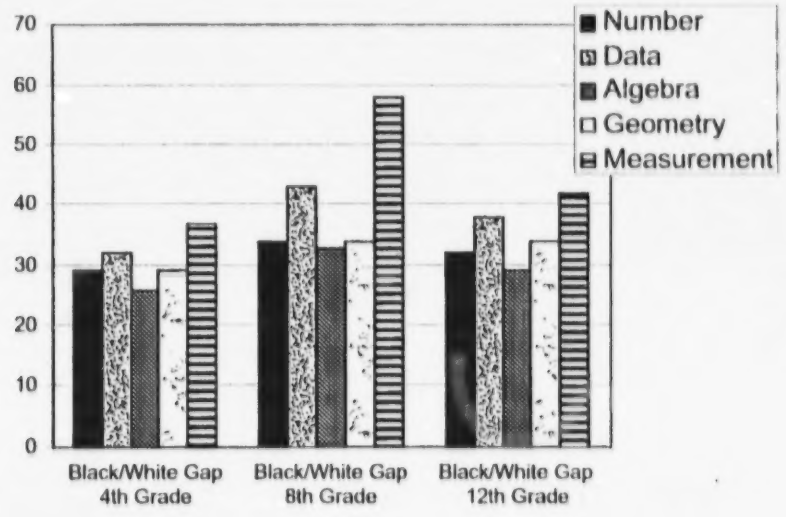

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Table 5: Student Beliefs About the Nature of Mathematics, 2000

	Percentage of students agreeing with the statement, "There is only one correct way to solve a math problem."			Percentage of students agreeing with the statement, "Learning mathematics is mostly memorizing facts."		
	4th	8th	12th	4th	8th	12th
2000						
All White Students	13	7	5	48	31	31
All Hispanic Students	24	15	8	59	48	47
All Black Students	25	13	5	61	55	55
Lowest-SES Black Students	28	14	5	59	58	58
Lowest-SES Hispanic Students	30	16	9	60	50	49
Lowest-SES White Students	19	11	7	63	39	41
Highest-SES Black Students	21	9	5	62	43	38
Highest-SES Hispanic Students	14	13	7	51	40	34
Highest-SES White students	10	5	5	41	26	24

Table note: The percentages listed are row percents. For example, 13% of White 4th graders agreed with the statement, "There is only one correct way to solve a math problem."

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Figure 5: Percentage of 8th Graders Whose Teachers Reported Their Students Use Calculators "A*lmost Every Day*," by Race

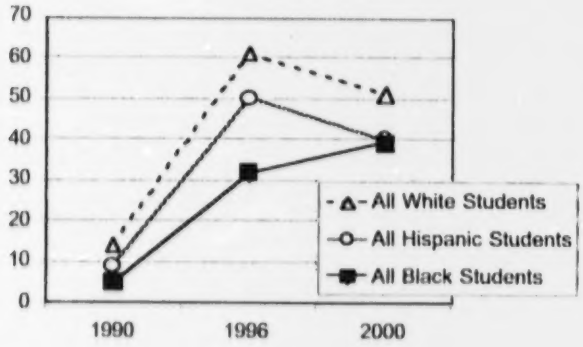

Figure 6: Percentage of 8th Graders Whose Teachers Reported Allowing Students to Use *Calculators on Tests*, By Race

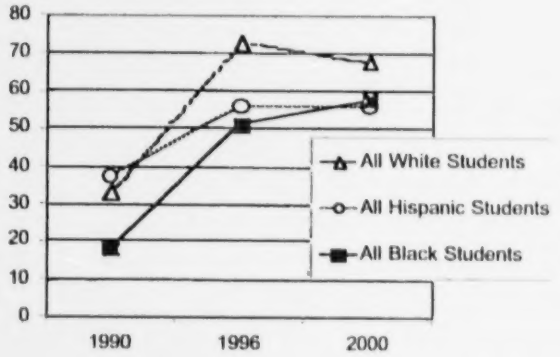

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Table 6: Eighth Grade Calculator Use by Race and SES, 2000

	Percentage of 8th graders whose teachers responded "almost every day" to "How often do students use a calculator?"	Percentage of 8th graders whose teachers responded "yes" to "Do you permit the use of calculators on tests?"
All Black Students	39	58
All Hispanic Students	41	57
All White Students	51	68
Lowest-SES Black Students	*37*	*57*
Lowest-SES Hispanic Students	*37*	*52*
Lowest-SES White Students	***47***	***65***
Highest-SES Black Students	***43***	***61***
Highest-SES Hispanic Students	*56*	*65*
Highest-SES White students	*56*	*72*
Low-SES Schools	*41*	*57*
High-SES Schools	*53*	*67*
Low-SES Black Students in Low-SES Schools	*39*	*56*
Low-SES Hispanic Students in Low-SES Schools	*37*	*47*
Low-SES White Students in Low-SES School	*46*	*66*

Table Note: The percentages given are row percents. For example, 39% of black 8th graders had teachers who reported that students use calculators "almost every day."

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Figure 7: Primary use of computers for mathematics instruction by race/SES of 8th grade student (teacher reported)

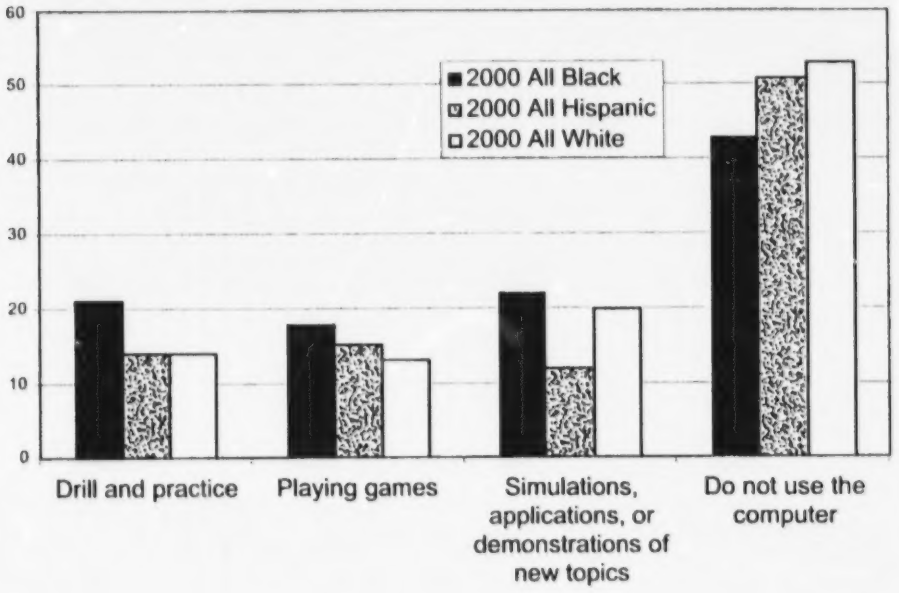

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Figure 8: Percentage of 4th and 8th Graders Whose Teachers Reported Using Multiple Choice Assessments At Least Once or Twice a Month, 1996-2000

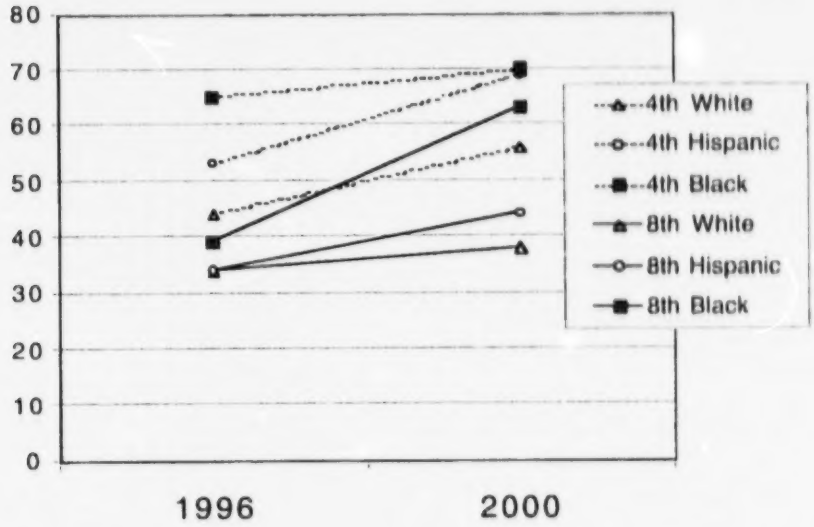

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Table 7: Percentage of students whose teachers reported being at least "somewhat knowledgeable" about the NCTM *Standards* by race and lunch eligibility, 1996-2000

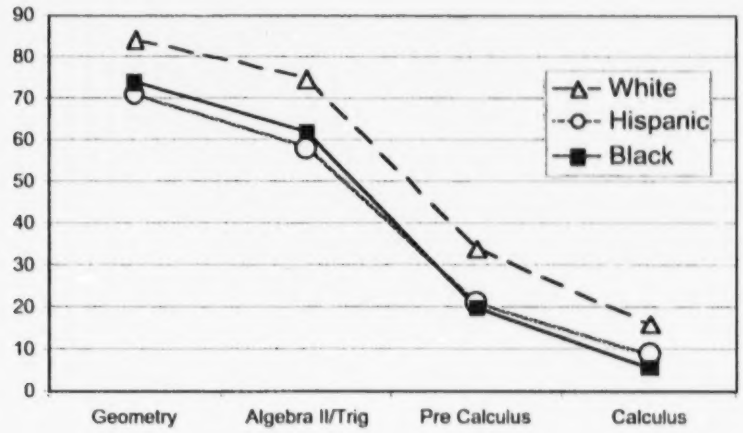
	4th Grade	8th Grade
1996		
White students	54	81
Hispanic Students	54	79
Black Students	59	84
2000		
White students	66	89
Hispanic Students	59	83
Black Students	64	85

Table 8: Teacher Educational Background by Race and SES, 2000

	Certified in Elementary (or middle school) Education	Certified in Secondary Mathematics	Hold at least a Master's Degree	
	4th	8th	4th	8th
White students	96%	80%	40%	44%
Hispanic Students	92%	72%	41%	41%
Black students	92%	72%	40%	45%
TOTAL	95%	78%	40%	44%

Table note: The percentages given are row percents. For example, 96% of white 4th graders are certified in elementary (or middle school) education.

Figure 9: Percentage of 12th Graders Who Reported Having Taken High School Mathematics Courses by Race, 2000



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